SYNTHESIS

Table 2. Reduction of Diynols **1**, **4**, **6** and Alkynol **8** to Ene-yn-ols **2**, **5**, **7** and Alkenols **9**, respectively

Educt	R^1	R^2	Reagent(s)	Product	(E/Z) ratio[a]	Yield[b] [%]	Reaction conditions solvent/temp [°C]/time [h]	b.p. [°C]/torr	Molecular formula[c] or Lit. data	M.S. (m/e)	I.R. (CCl_4) ν[cm^{-1}]	^{1}H-N.M.R. ($CDCl_3$/TMS) δ [ppm]
1a	n-C_7H_{15}	H	n-C_4H_9Li/DIBAH	**2a**[d]	96/4	70	THF/ $-80° \rightarrow 0°$/2	100°/0.02	$C_{12}H_{20}O$ (180.3)	180 (M^+) 163 ($M^+ + 1 - 18$)	3600 (OH) 2220 (C≡C) 1020 (C—O) 950 (C=C)[i]	0.88 (t, 3H); 1.20–1.40 (m, 8H); 1.40–1.65 (m, 2H); 2.29 (t, 2H, J = 6.9 Hz); 4.19 (d, 2H, J = 4.3 Hz); 5.7 (d, 1H, J = 15.8 Hz); 6.16 (m, 1H, J = 15.9 Hz, J = 5.3 Hz)
			$LiAlH_4$	—[e]	99/1	50	THF/reflux/12					
				—[f]	99/1	83[g]	THF/room temp/12					
				—[h]	99/1	69[g]	ether/reflux/12					
1b	n-C_4H_9	CH_3	n-C_4H_9Li/DIBAH	**2b**	99/1	70	THF/room temp/12	90°/0.4	$C_{10}H_{16}O$ (152.2)	152 (M^+) 135 ($M^+ + 1 - 18$)	3600 (OH) 2210 (C≡C) 960 (C=C)[i]	0.91 (t, 3H); 1.28 (d, 3H); 1.37–1.50 (m, 4H); 2.30 (t, 2H, J = 5.4 Hz); 4.30 (m, 1H, J = 6.2 Hz); 5.67 (d, 1H, J = 16 Hz); 6.07 (dd, 1H, J = 15.8, J = 6.1)
			$LiAlH_4$		99/1	70	THF/room temp/12					
1c	n-C_4H_9	n-C_3H_7	n-C_4H_9Li/DIBAH	**2c**	99/1	80[g]	THF/ $-80° \rightarrow$ room temp/12	102°/0.02	$C_{12}H_{20}O$ (180.3)	180 (M^+) 163 ($M^+ + 1 - 18$)	3620 (OH) 2210 (C≡C) 960 (C=C)[i]	0.92 (m, 6H); 1.20–1.70 (m, 8H); 2.30 (t, 2H, J = 5.7 Hz); 4.13 (m, 1H); 5.67 (d, 1H, J = 15.9 Hz); 6.03 (q, 1H, J = 15.8 Hz, J = 6.4 Hz)
4	n-C_8H_{17}	H	$LiAlH_4$	**5**	–	75	ether/reflux/12	125°/0.1	$C_{14}H_{24}O$ (208.4)	209 ($M^+ + 1$) 191 ($M^+ + 1 - 18$)	3260 (OH) 2200 (C≡C) 1050 (C—O) 960 (C=C)[i]	0.88 (t, 3H); 1.20–1.80 (m, 12H); 2.28 (t, 2H, J = 7.2 Hz); 2.35 (dt, 2H, J = 15.2 Hz); 3.67 (t, 2H, J = 6.3 Hz); 5.57 (d, 1H, J = 15.7 Hz); 6.02 (m, 1H, J = 15.8 Hz)
			n-C_4H_9Li/DIBAH	—[j]	–	–	THF/ $-80° \rightarrow 0°$/2[k]					
6	n-$C_{11}H_{23}$	H	$LiAlH_4$	**7**	–	94	THF/reflux/12	105°/0.07	$C_{14}H_{28}O$ (212.4)	213 ($M^+ + 1$) 195 ($M^+ + 1 - 18$)	3620 (OH) 1090, 1000 (C—O) 970 (C=C)[i]	0.88 (t, 3H); 1.2–1.4 (m, 18H); 2.03 (dt, 2H, J = 7.1 Hz); 4.01 (d, 2H, J = 4.4 Hz); 5.6 (m, 2H)
			n-C_4H_9Li/DIBAH	—[j]	–	–	THF/ $-80° \rightarrow 0°$/2[k]					
8	n-$C_{10}H_{21}$	H	$LiAlH_4$	**9**	–	94	diglyme/100°/12	—[l]	—[l]	—[l]	—[l]	—[l]

[a] The (E/Z)-ratio was determined by G.L.C. analysis on carbowax capillary column.
[b] Isolated yield, not optimized.
[c] Satisfactory microanalyses obtained: C ±0.44, H ±0.2.
[d] Compound **3** was obtained as a side product; ratio of **2a** : **3** = 97 : 3.
[e] Ratio of **2a** : **3** = 59 : 41; **3**: b.p. 100 °C/0.02 torr.
$C_{12}H_{22}O$ calc. C 79.06 H 12.16
(182.3) found 78.85 12.00
I.R. (CCl_4): ν = 3650 (OH), 1970 (C=C=C), 1050 cm^{-1} (C—O).
^{1}H-N.M.R. ($CDCl_3$/TMS): δ = 0.88 (t, 3H); 1.20–1.60 (m, 10H); 2.0 (m, 2H, J = 7.3 Hz); 2.25 (m, 2H, J = 4.3 Hz); 3.7 (t, 2H, J = 6.2 Hz); 5.09 (m, 1H, J = 6.6 Hz); 5.15 ppm (m, 1H, J = 6.3 ppm).
^{13}C-N.M.R. ($CDCl_3$/TMS): δ = 87.16 (d); 91.66 (d); 204.64 ppm (s).
M.S.: m/e = 183 ($M^+ + 1$), 165 ($M^+ + 1 - 18$).
[f] Ratio of **2a** : **3** = 96 : 4.
[g] These results were difficult to reproduce.
[h] Ratio of **2a** : **3** = 94 : 6.
[i] $\delta_{C=C}$ for (E)-configuration.
[j] No reaction.
[k] Use of higher temperature might result in reduction.
[l] See Ref. [19].

reduction. Adding the DIBAH at higher temperatures or substituting other solvents such as digylme or ether resulted in lower yields and increased by-products, particularly the allene **3** and the *cis*-isomer.

The regioselectivity of the *n*-butyllithium/DIBAH reduction system should make this method applicable to the selective reduction of complex acetylenic alcohols containing more than one type of triple bond and/or other functionalities incompatible with lithium aluminium hydride. In addition, it is possible to generate the lithium alkoxide salt with bases other than *n*-butyllithium.

I.R. spectra were obtained on a Perkin Elmer 467 spectrophotometer. Mass-spectral data were obtained with a Finnigan Model 105C chemical ionization mass spectrometer equipped with a chromatographic inlet (Varian Model 1400). A 32 mm × 15 m fused silica DB-1 capillary column was used at a linear flow velocity of 20 cm/sec and temperature programmed from 80° to 230 °C. Gas liquid chromatography analyses were performed with a Varian 2100 instrument employing a 0.25 × 15 m fused silica capillary column coated with 0.25 μm of Carbowax 20 M operating at linear flow velocity of 18 cm/sec and a temperature of either 145° or 190 °C. A Varian 1200 instrument employing a 0.25 mm × 15 m fused silica DB-1 capillary column operating at a linear flow velicity of 18 cm/sec and a temperature of 150 °C also was used for some analyses. Melting points were obtained with a Mel-Temp melting point apparatus and are uncorrected. ^{1}H- and ^{13}C-N.M.R. spectra were obtained using a Nicolet NT-300 FT ^{1}H-N.M.R. 300 MHz and FT ^{13}C-N.M.R. – 75 MHz respectively.

The propargyl alcohol **6** was prepared from 1-tridecyne, *n*-butyllithium and paraformaldehyde adopting the literature procedure[16] for other propargyl alcohols. The homopropargyl alcohol **8** was prepared according to the reported method[17].

6; m.p. 42–43 °C.

$C_{14}H_{26}O$	calc.	C 79.94	H 12.46
(210.3)	found	79.81	12.27

I.R. (CCl_4): $v = 3620$ (OH), 2220 (C≡C), 1010 cm^{-1} (C—O).

^{1}H-N.M.R. ($CDCl_3$/TMS): $\delta = 0.88$ (t, 3H); 1.20–1.60 (m, 18H); 2.20 (tt, 2H, $J = 5.0$ Hz); 4.25 ppm (S, 2H).

M.S.: $m/e = 211$ ($M^+ + 1$), 193 ($M^+ + 1 - 18$).

The unknown diynols **1a–c** and **4** were prepared via the Cadiot-Chodkiewicz coupling reaction[18] (Table 1).

Reduction of Alkynols 1,4,6, and 8 to (*E*)-Alkenols 2,5,7, and 9 with *n*-Butyllithium/Diisobutylaluminium Hydride; General Procedure:
To a stirred solution of the appropriate alkynol **1**, **4**, **6**, or **8** (10 mmol) in dry tetrahydrofuran (25 ml) at −80 °C is added dropwise a 22% solution of *n*-butyllithium in heptane (4.58 ml, 11 mmol). A solution of diisobutylaluminium hydride in heptane (11 ml, 11 mmol) is then added dropwise and stirring is continued for 1 h at the same temperature. The mixture is allowed to come to 0 °C in an ice-bath and is held at that temperature for 2 h. It is worked up by chilling to − 80 °C and slowly adding 1 normal hydrochloric acid (20 ml). The mixture is extracted with ether (4 × 20 ml), the combined ether extracts are washed with water (4 × 20 ml), saturated sodium hydrogen carbonate (2 × 20 ml), and dried with sodium sulfate. After removal of the solvent, the residual oil is vacuum distilled (for exact reaction conditions in particular cases, see Table 2).

Comparative Reduction of Alkynols 1,4,6, and 8 to (*E*)-Alkenols 2,5,7, and 9 with Lithium Aluminium Hydride; General Procedure:
The alkynol **1**, **4**, **6**, or **8** (5 mmol) is treated with lithium aluminium hydride (10–12 mmol),in dry solvents and for times indicated in Table 2. The reaction is worked up by cooling in an ice-bath, adding consecutively water (1 ml), 15% sodium hydroxide (1 ml), and water (3 ml) in that order for each gram of lithium aluminium hydride used and stirring until the formation of the filterable, granular precipitate of aluminium hydroxide is complete. The filtrate is evaporated and the residual oil purified by vacuum distillation.

Note added in proof: The use of methyllithium to generate the lithium alkynoxide is more satisfactory than *n*-butyllithium.

* Mention of a commercial or proprietary product does not constitute an endorsement by the USDA.

1 R.A. Raphael, *Acetylenic Compounds in Organic Synthesis*, Butterworth and Co. Ltd., London, 1955, p. 29.
2 J. Attenburrow, A.F.B. Cameron, J.H. Chapman, R.M. Evans, B.A. Hems, A.B.A. Jansen, T. Walker, *J. Am. Chem. Soc.* **74**, 1094 (1952).
3 J.S. Pitzer, *Synthetic Reagents*, Vol. I, John Wiley & Sons, Inc., New York, 1974, p. 232.
4 F. Bahlman, R. Enkelmann, W. Plettner, *Chem. Ber.* **97**, 2118 (1964).
5 R. Riemschneider, G. Kasang, C. Böhme, *Monatsh. Chem.* **96**, 1766 (1965).
6 S.R. Landor, E.S. Pepper, J.P. Regan, *J. Chem. Soc.* [C], **1967**, 189.
7 R. Rossi, A. Carpita, *Synthesis* **1977**, 561.
8 B.B. Malloy, K.L. Hauser, *J. Chem. Soc. Chem. Commun.* **1968**, 1017.
9 W.T. Bardon, *J. Am. Chem. Soc.* **92**, 4898 (1970).
10 B. Grant, C. Djerassi, *J. Org. Chem.* **39**, 968 (1974).
11 E.J. Corey, J.A. Katzenellenbogen, G.H. Posner, *J. Am. Chem. Soc.* **89**, 4245 (1967).
12 E.J. Corey, J.A. Katzenellenbogen, N.W. Gilman, S.A. Roman, B.W. Erickson, *J. Am. Chem. Soc.* **90**, 5618 (1968).
13 T.B. Patrick, G.F. Melm, *J. Org. Chem.* **44**, 645 (1979).
14 G. Wilke, H. Mueller, *Chem. Ber.* **89**, 444 (1956).
15 G. Zweifel, R.B. Steele, *J. Am. Chem. Soc.* **89**, 5085 (1967).
16 A. Schoop, L. Brandsma, J.F. Arens, *Recl. Trav. Chim. Pays-Ba* **84**, 1200 (1965).
17 R.E. Doolittle, *Org. Prep. Proced. Int.* **12**, 1 (1980).
18 W. Chodkiewicz, P. Cadiot, *C.R. Acad. Sci. Ser. C* **241**, 1055 (1955).
19 R.E. Doolittle, *Org. Prep. Proced. Int.* **13**, 179 (1981).

Improved Synthesis of Formyl-halo-malonic Ester Derivatives

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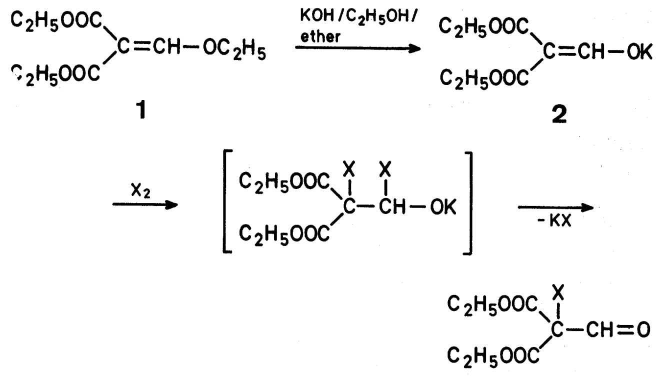
Malonic ester derivatives are widely used synthetic intermediates. Recently, the acetal derivative **4** has been proposed[1] to be useful for preparing medicinally important substances. Although **4** was not isolated[1], its presence and yield were ascertained by spectrometry. We now report a facile preparative procedure for obtaining **4** in isolated form from its aldehyde precursor **3**, and also describe the synthesis of several related compounds and derivatives.

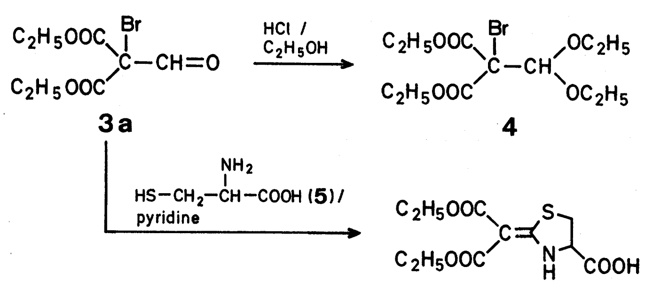
The preparation of diethyl ethoxymethylenemalonate (**1** and of the potassium salt **2** have been previously reported[2] When dry **2**, suspended in carbon tetrachloride was halogenated at 0 °C, 65–70% yields of the 2-formyl-2-halomalonic esters **3** were obtained.



3a X = Br
b X = Cl

The properties of the bromoaldehyde **3a**, which has been more thoroughly investigated than the chloro compound, are unusual. The compound gives a positive fuchsin aldehyde test, and readily provides a 2,4-dinitrophenylhydrazone. Other aldehydic properties of the diethyl 2-formyl-2-bromomalonate seem to be suppressed. No oxime, semicarbazone, or bisulfite addition product was obtained by usual procedures. The aldehyde is labile to alkali. Titration of an alcoholic solution indicates an alkali uptake of 0.5–0.6 milliequivalent per millimol of aldehyde. The bromine in either the aldehyde or its acetal is not removed by boiling alcoholic silver nitrate solution. Also, the bromoaldehyde liberates iodine from acidified potassium iodide solution, a typical reaction of positive or oxidizing halogen atoms.

The aldehyde **3a** is readily converted to its diethyl acetal **4**, the compound previously synthesized[1] by the reaction of diethyl α-bromomalonate with triethyl orthoformate. Reaction of **3a** with L-cysteine **(5)** gave the thiazolidine **6**. The thiazolidine structure was indicated by the close qualitative and quantitative agreement of its absorption spectrum with those of compounds containing similar types of conjugated systems, and by the isolation of diethyl oxomalonate as a product of oxidation of the compound by potassium permanganate. The oxidizing nature of the bromine atom in **3a** is further illustrated by the consistent production of substantial quantities of cystine, in addition to the thiazolidine **6**, when **3a** was reacted with L-cysteine **(5)**.



6

Diethyl 2-formyl-2-chloromalonate **(3b)** does not react readily with L-cysteine **(5)** to form a thiazolidine **6** under the experimental conditions used for the bromo compound.

Potassium Salt of Diethyl Hydroxymethylenemalonate (2):
Diethyl ethoxymethylenemalonate[2] (**1**; 225 g, 1.04 mol) is dissolved in dry ether (2.7 l) in a 5-liter three-necked flask equipped with a stirrer, a thermometer which extends into the liquid, and a dropping funnel. The mixture is cooled to 0 °C and one equivalent of approximately 1 normal potassium hydroxide in absolute ethanol is added dropwise with stirring over the period of 30–60 min. The solution turns light yellow. Within about 15 min precipitation of the potassium salt begins. The temperature is maintained at ± 1 °C. After about an h the flask contains a yellow mush. After approximately two more h the potassium salt is separated by filtration and dried in vacuo (213 g). Recrystallization from absolute ethanol gives pure **2**; yield 60.4 g (26%); m.p. 240 °C.

$C_8H_{11}O_5K$	calc.	K 17.28
(226.3)	found	17.40

The potassium salt is further characterized by the preparation of its acetate; **2** is reacted with acetyl chloride in dry ether, first in the cold, then under reflux for 2 h and worked up in the usual manner to give *diethyl acetoxymethylenemalonate*; b.p. 106–110 °C/0.6 torr; d_{25}^{25}: 1.133; n_D^{25}: 1.4521.

U.V. (95% C_2H_5OH): $\lambda_{max} = 227.5$ nm ($\varepsilon = 660$).

Diethyl 2-Formyl-2-bromomalonate (3a):
Pure powdered **2** (71.7 g, 0.318 mol) is suspended in dry carbon tetrachloride (150 ml). To the cooled suspension is added, over the period of ~1 h, with intermittent shaking, a solution of bromine (50.9 g, 0.318 mol) in carbon tetrachloride (100 ml). The mixture is than allowed to stand at room temperature for 1 h. The potassium bromide is separated by filtration, and the filtrate is concentrated in vacuo in a stream of nitrogen to give 69.0 g of crude product. This is fractionally distilled in vacuo in a stream of nitrogen to give pure **3a**; yield: 56.2 g (66%); b.p. 81–85 °C/0.5 torr; d_{24}^{24}: 1.430; n_D^{25}: 1.4581.

$C_8H_{11}BrO_5$	calc.	C 35.97	H 4.15
(267.1)	found	36.10	4.24

U.V. (95% C_2H_5OH): $\lambda_{max} = 247.5$ nm ($\varepsilon = 62.1$).

Diethyl 2-formyl-2-bromomalonate **(3a)** is sensitive to alkali and to oxidation by air. The compound should be placed under nitrogen as soon as distilled and stored out of contact with the air.

2,4-Dinitrophenylhydrazone of **(3a)**; m.p. 133–135 °C (ethanol).

$C_{14}H_{15}BrN_4O_8$	calc.	Br. 17.87	N 12.53	OCH_2CH_3 20.2
(447.2)	found	17.50	12.60	20.3

Diethyl 2-Formyl-2-chloromalonate (3b):
Recrystallized **2** (15 g, 0.067 mol) is suspended in carbon tetrachloride (100 ml). The mixture is cooled in an ice bath, and dry chlorine gas is passed in until a weight increase of 4.7 g is obtained (~2 h). The solid potassium salt goes into solution and a gelatinous precipitate appears. After keeping for 2 h longer at room temperature, the precipitate is separated by filtration, the filtrate is concentrated in vacuo, and fractionated to give **3b**; yield: 10.4 g (69%); b.p. 80–82 °C/0.8 torr; d_{25}^{25}: 1.202; n_D^{25}: 1.4348.

$C_8H_{11}ClO_5$	calc.	C 43.17	H 4.98
(222.6)	found	42.80	5.21

2,4-Dinitrophenylhydrazone of **3b**; m.p. 128–129 °C.

$C_{14}H_{15}ClN_4O_8$	calc.	OCH_2CH_3 22.4	Cl 8.80
(402.8)	found	22.6	8.73

Diethyl 2-Formyl-2-bromomalonate Diethyl Acetal (4):
Diethyl 2-formyl-2-bromomalonate (**3a**; 83.3 g, 0.31 mol) is dissolved in 6.3 normal hydrogen chloride in absolute ethanol (350 ml) which has previously been cooled in an ice bath. The mixture is kept cool for 1 h and then allowed to stand at room temperature overnight. The alcoholic hydrogen chloride is removed in vacuo (nitrogen), an additional quantity of dry ethanol added, and the solution concentrated again. The residue is then exactly neutralized (pH test paper) with sodium ethoxide in absolute ethanol and filtered. The salt is washed with small portions of absolute ethanol, concentrated in vacuo and distilled; yield: 32.98 g (31%); b.p. 114–115 °C/0.5 torr; d_{24}^{24}: 1.274; n_D^{25}: 1.4533.

$C_{12}H_{21}BrO_6$	calc.	OCH_2CH_3 52.8	Br 23.42
(341.2)	found	52.4	23.20

L-2-(Diethoxycarbonylmethylene)-thiazolidine-4-carboxylic Acid (6):
To L-cysteine hydrochloride monohydrate (**5**; 11.0 g, 0.07 mol) in water is added diethyl 2-formyl-2-bromomalonate (**3a**; 16.8 g, 0.049 mol) in absolute ethanol (35 ml). The reaction mixture becomes warm. After allowing the mixture to stay overnight under nitrogen, pyridine (6.1 g) is added, whereupon an immediate precipitation of *l*-cystine (2.1 g) occurs. This is filtered after several h.

The filtrate is made alkaline with an excess of saturated sodium hydrogen carbonate solution, extracted several times with chloroform, and then acidified with hydrochloric acid to a pH of 2. The product precipitates as a gummy solid which soon flocculates on standing; crude yield: 4.0 g (22%); m.p. 157–160 °C. Occasionally the crude thiazolidine contains cystine. This is easily removed by recrystallization from methanol in which cystine is insoluble. The thiazolidine can also be recrystallized from ethanol or 50% ethanol; m.p. 158–160 °C.

$C_{11}H_{15}O_6NS$
(289.3)

calc.	C 45.67	H 5.23	N 4.84	S 11.08	OCH_2CH_3 31.1
found	45.80	5.24	4.93	11.20	30.6

U.V. (C_2H_5OH): λ_{max} = 280 nm (ε = 700).

Oxidation of Thiazolidine 6 with Potassium Permanganate:
To the thiazolidine (**6**; 1 g, 3.5 mmol) dissolved in glacial acetic acid (100 ml) is added dropwise with stirring a solution containing potassium permanganate (3 g, 0.019 mol) in water (75 ml). The mixture becomes warm and the permanganate is rapidly decolorized. Stirring is continued for 4 h at room temperature and the mixture is allowed to stand overnight. After filtration and decolorization of the filtrate with gaseous sulfur dioxide, the filtrate is diluted with water and continuously extracted for several h with ether. Evaporation of the ether and acetic acid in vacuo leaves a partially crystalline material which is used directly for the preparation of hydrazone derivatives.

2,4-Dinitrophenylhydrazone of Diethyl Oxomalonate:
This is prepared by treating the residue from the oxidation of **6** obtained as above with a strongly acidified (sulfuric acid) aqueous alcoholic solution of 2,4-dinitrophenylhydrazine; m.p. 115–117 °C (ethanol) (Lit.[3], m.p. 128 °C).

$C_{13}H_{14}N_4O_8$	calc.	C 44.07	H 3.98	N 15.81	OCH_2CH_3 25.4
(354.3)	found	44.90	4.36	15.60	24.8

The residue from the oxidation is allowed to react with *p*-tolylhydrazine in dilute acetic acid to give a hydrazone, which is identified as the hydrazone of oxomalonic acid monomethyl ester; m.p. 140–142 °C (light petroleum) (Lit.[4], 139.5 °C).

The experimental work described in this paper was performed at the Northern Regional Research Center of U.S.D.A.'s Agricultural Research Service, Peoria, Illinois.

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[1] R.A. Swaringen, Jr., D.A. Yeowell, J.C. Wisowaty, H.A. El-Sayad, E.L. Steward, M.E. Marnofall, *J. Org. Chem.* **44**, 4825 (1979).
[2] W.E. Parham, L.J. Reed, *Org. Synth. Coll. Vol.* III, 395 (1955); L. Claisen, *Liebigs Ann. Chem.* **297**, 76 (1897).
[3] C.F.H. Allen, *J. Am. Chem. Soc.* **52**, 2955 (1930).
[4] H. von Pechmann, *Ber. Dtsch. Chem. Ges.* **27**, 1688 (1894).

Eine einfache Synthese von Dichloromethyl-ketonen (1,1-Dichloro-2-alkanonen)

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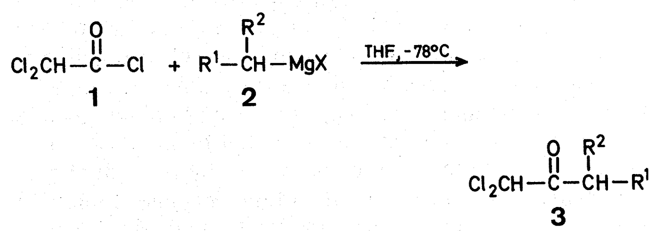
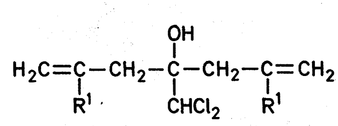
Dichloromethyl-ketone **(3)** sind auf mehreren Wegen zugänglich[1–5]. Mit Ausnahme der Synthese aus Carbonsäure-estern und Dichloromethyllithium[3] sind alle Synthesen mehrstufig[11].

Nachdem wir gefunden hatten, daß aus 1,1- und 1,3-Dichloro-2-alkanonen in inter-[6] und intramolekularer[7] Reaktion 3-Oxo-8-oxabicyclo[3.2.1]oct-6-ene hergestellt werden können, waren wir an einer möglichst einfachen Synthese der Ketone **3** interessiert. Über die Synthese von Ketonen aus Grignard-Verbindungen und Carbonsäure-chloriden[8] sowie die Bildung von α-Chloroketonen aus α-Chlorocarbonsäure-chloriden und Grignard-Verbindungen und ihre Umsetzung *in situ* zu Alkenen[9] ist berichtet worden.

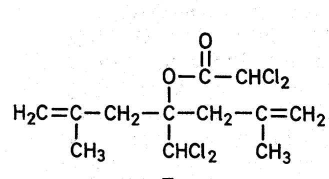
Die hohe *CH*-Acidität von Dichloroacetyl-chlorid **(1)**, die sich in der raschen HCl-Eliminierung zu Dichloroketen bemerkbar macht, ließ seine Umwandlung in Dichloromethyl-ketone nach Lit.[8] fraglich erscheinen. Dennoch fanden wir, daß Dichloromethyl-ketone auf einfache Weise hergestellt werden können, wenn man in Tetrahydrofuran bereitete Grignard-Reagentien unter Schutzgas-Atmosphäre zu einer auf − 75 °C gekühlten Lösung von Dichloroacetyl-chlorid **(1)** in Tetrahydrofuran tropfen läßt.



Wie die in der Tabelle aufgeführten Beispiele zeigen, lassen sich so auch Dichloromethyl-ketone mit geschützten Funktionen **(3f, g)** synthetisieren. Mit sekundären Grignard-Verbindungen **(2h, i)** sind die Ausbeuten unbefriedigend. Allyl- und Methallylmagnesium-chlorid sind so reaktiv, daß sie bereits bei − 75 °C an die offenbar aktivierte Carbonyl-Gruppe der primär gebildeten Dichloromethyl-allyl-ketone **(3j, k)** addiert werden und die tertiären Alkohole **4j, k** sowie das Dichloroacetyl-Derivat **5** liefern.



4j R^1 = H
4k R^1 = CH_3



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